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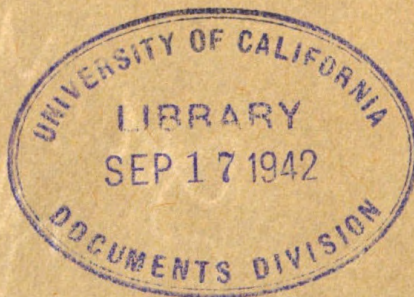
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WAR DEPARTMENT

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TECHNICAL MANUAL

ORDNANCE MAINTENANCE
3-INCH ANTIAIRCRAFT GUN
MATÉRIEL, M2A2, M2A1, M1A2,
M1A1, T1A2, AND T1A1



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WAR DEPARTMENT,
WASHINGTON, July 25, 1940.

ORDNANCE MAINTENANCE

3-INCH ANTIAIRCRAFT GUN MATÉRIEL, M2A2, M2A1, M1A2, M1A1, T1A2, AND T1A1

Prepared under direction of the
Chief of Ordnance

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SECTION I

GENERAL

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1. Purpose.—The purpose of this manual is to furnish suitable instructions for the maintenance and shop repair of the 3-inch anti-aircraft gun matériel, M2A2, M2A1, M1A2, M1A1, T1A2, and T1A1. It is for use of ordnance maintenance companies, civilian employees of the Ordnance Department, Ordnance Reserve Officers' Training Corps, National Guard, and Reserve officers charged with the maintenance and repair of this matériel.

2. Scope.—This manual contains instructions for inspection, disassembly and assembly, and maintenance and repair, supplementary to those covered in TM 9-360. *These operations should be conducted in accordance with the procedure outlined in TM 9-1100.* It also describes and prescribes the use of special repair tools.

3. References.—The Appendix lists all Technical Manuals, Ordnance Field Service Bulletins, Ordnance Proof Manual, Standard Nomenclature Lists, drawings, and other publications relating to the matériel described herein.

SECTION II

TOOLS FOR INSPECTION

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4. General.—The tools for inspection and those pertaining to maintenance and repair are issued as a set of special repair tools, and are so listed in section IV, SNL D-14.

5. Tools for inspection.—The following tools are used in the inspection of the gun and carriage by the ordnance maintenance companies:

a. Sights, bore.—The bore sights are used in the verification and adjustment of director firing system.

b. Ammeter.—The ammeter is used in testing the electric current at the brakes.

c. Gage, armature.—The armature gage (fig. 11) is used when testing the distance between the armature and the magnet of the electric brakes.

d. Gage, tire.—The tire gage is used when testing the pressure in the balloon tires.

SECTION III

INSTRUCTIONS FOR INSPECTION

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6. General.—*a.* Inspection is for the purpose of determining the condition of the matériel, whether repairs or adjustments are required, and the remedies necessary to insure that the matériel is in serviceable condition.

b. The use of the artillery gun book (O.O. Form 5825), is outlined in the book. See also OFSB 4-1.

c. (1) The estimated average accuracy life in full service rounds of the 3-inch antiaircraft guns, M1 and M3, is 2,500 rounds. The guns in service will be star-gaged at approximately 10 percent and 90 percent of their estimated average accuracy life in rounds fired, and thereafter at each 10 percent during the remainder of their service. Also, they should be star-gaged at any time an inspector may deem it necessary on account of doubtful conditions, or when the bores show signs of unusual wear or other irregularities. Decoppering of the bores of cannon before star-gaging is prohibited. When star-gaging

these guns the greatest distance from the muzzle at which star-gage measurements are to be made is 126 inches.

(2) For pastilles, or other defects of the bore of the guns requiring accuracy in measurement, plaster of paris should be used if practicable, as it gives a harder surface than gutta-percha and a more accurate measurement.

7. Inspection of gun and mount.—The inspection of the gun and mount and the instructions for inspection and verification of adjustment of director firing system as outlined in TM 9-360 should be followed. The following additional inspection of the mount and recoil mechanism should be adhered to:

a. Mechanism, recoil.—The recoil mechanism should be inspected as follows:

(1) The proper "full oil reserve" in this system is an amount equal to two oil screw fillersfull in excess of the quantity which can be poured into the recoil cylinder filling hole with the gun at maximum depression and proper gas pressure. With the recoil cylinder filled, any slight amount of reserve oil forced past the valve, A21027 (fig. 5), will force the floating piston away from the rear end of its cylinder and establish pressure in the oil side of the system to the extent of the nitrogen pressure present on the front face of the floating piston. To maintain this "system pressure" against periodical losses in reserve oil, the two oil screw fillersfull of reserve oil have been established as a proper amount for forcing the floating piston an appreciable distance away from its rearmost position. The expedient of forcing additional charges of reserve oil into the system to increase gas pressure is *definitely prohibited*.

(2) Remove the filling valve seat plug, A21185 (fig. 5), and examine for leakage. The valve should hold the pressure independently of the filling plug.

(3) Examine the buffer cylinder head follower for oil leakage.

(4) Examine the extension piston and piston rod for unusual signs of wear or scored surfaces.

b. Equilibrator.—(1) Examine the seal around the gasket, A146977, and plug, A146981, of the gas filling valve (fig. 8) for gas leaks. With this plug removed, for attaching the nitrogen charging apparatus, a slight leak of gas through the valve, A138814, may be tolerated if it does not interfere with the connecting of the filling tube or reassembly of the plug. Extreme care should be observed when unscrewing filling valve plugs from charged mechanisms, as badly worn check valve gaskets will permit the pressure to build up against the plug. Such conditions will be evident if a continuous hiss of gas is heard through the threads as the plug is being unscrewed and also

by the effort required to rotate the plug after it has moved away from its seat on the copper gasket.

(2) Examine the plunger for unusual wear or scored surface.

(3) Note condition of equilibrator plunger cover.

(4) Note condition of the volume control device and see that it functions properly.

(5) Note if groaning or squeaking noises emanate from either equilibrator on the gun mount while the gun is being slowly elevated or depressed. Noises of this kind indicate a binding in the equilibrator assembly which is probably caused by the extended plunger being forced out of the vertical plane normal to the axis of the equilibrator trunnions and, through distortion of the assembly, will permit gas pressure to escape past the piston packings. Conditions of this nature should be reported to the Chief of Ordnance. This report should include the gun mount serial number, the side of mount (right or left when facing the breech) on which the defective equilibrator is installed, and all other pertinent data.

8. Nitrogen pressure.—*a.* To determine whether or not the system is totally void of pressure (with a total void the recoil would be out of control if the gun were elevated and possibly damage the mechanism or injure the personnel), the gun jack test should be performed at zero elevation and if the gun returns to battery it indicates that there is sufficient gas pressure in the system for safe elevation of the piece. In performing the gun jack test, the jack screw should be turned with the special wrench until the gun has been backed out of cradle to the limit of the screw. The presence of gas pressure is indicated when the gun returns to its stop against the cradle as the screw of the gun jack is collapsed. A clearance of about $\frac{1}{8}$ inch should be obtained between the fully collapsed screw and the adjacent surface of breech ring when the gun is in battery.

b. Proper service pressure (1,080 pounds per square inch) is indicated when the gun has been jacked back while at maximum elevation, the jack screw then collapsed, and the gun returned to battery before the elevation has been reduced to 50°.

NOTE.—Should the gun start to slide to the rear while being elevated, either a gas pressure below service requirements is indicated or the pressure may be normal and a definite void exists in the oil of the recoil cylinder. (See instructions in TM 9-360.)

9. Replenishing gas pressure in recuperator.—Remove the air filling valve plug housing plug, A146981 (fig. 7), and assemble the air filling tube (fig. 1) with gage attached as shown on figure 3. Remove the cap, A2056, below the pressure gage and attach the flexible air filling tube (fig. 2) which also is connected to the nitrogen gas cylin-

der. Close the air release valve, A2092 (fig. 1), and turn the handle, B128862, of the valve opener, B128861, until the air filling valve is forced open. Then open the nitrogen gas cylinder valve slightly, allowing gas to flow into the recuperator very slowly. Close the nitrogen gas cylinder valve when a pressure of 1,100 pounds is registered on the pressure gage. Turn the valve opener handle, B128862 (fig. 1), and allow the air filling valve, A138814 (fig. 7), to close on its seat. Disassemble the flexible filling tube (fig. 2) from the air filling tube (fig. 1) and replace the cap, A2056. Lift the air filling valve, A138814 (fig. 7), again from its seat by turning the valve opener handle. Observe the pressure registered on the pressure gage. If the pressure in the recuperator is above 1,080 pounds per square inch, open the air release valve, A2092 (fig. 1), and allow a slow escape of gas until the proper pressure is indicated. Close the air release valve, A2092. Remove the air filling tube (fig. 1) and replace the air filling valve plug, A146981 (fig. 7).

10. Replenishing gas in equilibrator.—*a.* Place the gun at approximately 20° elevation and adjust both volume control indices to 90 on their respective scales.

b. Attach the nitrogen filling equipment to one equilibrator in the position shown in figure 4, while following the instructions for manipulating the gas filling tube (fig. 1) as outlined for filling the recuperator in paragraph 9.

c. Charge 600 pounds of pressure into the first equilibrator, detach the filling equipment, replace the filling valve plug, A146981, and attach the filling equipment to the second equilibrator.

d. A moderate effort for elevating the gun should be applied on the elevating handwheels while the second equilibrator is being slowly charged. As soon as the handwheels start to turn, the flow of gas should be stopped and the elevating and depressing efforts at the handwheels should be observed for equal balance. The gas pressure should be adjusted by manipulating the filling and release valves of the charging apparatus until approximately equal handwheel efforts are obtained at that angle of elevation.

e. If a pressure of over 600 pounds is required in the second equilibrator to obtain balanced handwheel loads at 20° elevation of gun, it indicates that either the first equilibrator has leaked since filling or an abnormal condition exists in the balancing of the tipping parts which should be investigated rather than arbitrarily increasing the equilibrator pressure.

f. When balanced handwheel loads have been obtained, the air filling tube (fig. 1) should be detached from the recuperator filling valve

and the plug, A146981 (fig. 8), reassembled firmly on the gasket, A146977.

NOTE.—The equilibrators are now properly charged with the volume control indices at 90 which will permit a full range of periodical adjustment to offset pressure losses due to minor leaks, etc. However, the pressures should be replenished with the charging equipment as described above, when an adjustment of the volume control to the 40 graduation has failed to provide the desired hand-wheel loads. (On some mounts having structural variations, an adjustment to the 30 graduation will result in the contact of the equilibrator case and the top carriage when gun is at 80° elevation and may seriously damage the equilibrator.)

SECTION IV

TOOLS FOR MAINTENANCE AND REPAIR

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11. General.—A number of tools are provided for maintenance, repair, and adjusting of this matériel, such as chisels, drifts, files, hammers, pliers, screw drivers, punches, and wrenches, the name or general characteristics of which indicate their uses and application. Therefore, detailed description and method of use are not contained herein. Those tools, however, which are of special design and not commonly used are described and their uses outlined in paragraphs 12 to 16.

12. Release, liquid.—The liquid release, B7875, is used to drain the reserve oil from the recuperator system.

13. Tube, filling, air.—The air filling tube (fig. 1) consists of a T-shaped body, equipped with an air-release valve, A2092, the purpose of which is to allow the escape of excess pressure when opened. Through the center of the air filling tube is a valve opener, B128861, operated by a handle, B128862, the purpose of which is to raise the air filling valve, A138814 (fig. 7), from its seat in the recuperator or equilibrator when charging their mechanisms with nitrogen. A tee cap, A2056, covers an opening in a projection at right angles to the air-release valve. When charging the recuperator or equilibrator this tee cap is removed and a flexible filling tube (fig. 2) is connected to the projection and to the nitrogen cylinder. The opening in the hexagon portion of the body is for the attachment of the pressure gage.

14. Tube, filling, air, flexible.—The flexible air filling tube (fig. 2) consists of a soft copper tube, A2162, with tube ends and union nuts, A2166, and an adapter. The purpose of the filling air tube is to make a connection between the nitrogen cylinder and the air filling tube (fig. 1) when charging mechanisms with nitrogen gas.

15. Tube, recoil buffer spring compressor.—This tool, A20349, is a piece of $1\frac{1}{4}$ O. D. cold-drawn seamless steel tubing, 12 inches long, with a $1\frac{1}{4}$ -12NF-2 thread at one end. It is for the purpose of releasing the spring load when disassembling the buffer mechanism.

16. Filler, oil screw, M1.—The oil screw filler, C6150, is a high-pressure hand pump and is used only to replenish the reserve oil in the recuperator mechanism.

SECTION V

INSTRUCTIONS FOR MAINTENANCE AND REPAIR

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17. Breechblock seized.—*a.* If possible the breechblock should be forced open. The application of penetrating oil and other lubricants will assist in this operation. A lead hammer may be used on the breechblock or a suitable lever used to pry the block open. If the block cannot be opened by the above procedures, the gun should be sent to a manufacturing arsenal.

b. After the block has been forced open the cause of seizure should be determined and corrected. The guide surfaces of either, or both, the breechblock and breech-ring may be dressed down with a fine file or grinding and honed to remove all galling.

18. Equilibrator.—*a.* If an equilibrator will not hold the required gas pressure satisfactorily the following procedure should be followed, with the mechanism fully charged:

(1) With a soap solution or a light oil, check for leaks around the air filling valve and tighten parts as required. Gaskets, A146977 and A21032 (fig. 8), should be replaced by new gaskets when required. Care should be taken that the head, C63693, is not turned when removing the air filling valve assembly.

(2) Likewise, check for gas leaks around the retainers, B13713 and B13706, and tighten these parts as required.

Caution: The removal of the filling valve housing for renewing the gasket, A21032, should not be attempted until the pressure of gas has been exhausted from that cylinder.

b. If gas leaks cannot be stopped by the above procedures, or if the equilibrator becomes unserviceable for any other reason, the defective mechanism should be removed and shipped to a manufacturing arsenal for overhaul. The removal of an equilibrator may be accomplished by the following procedure:

(1) Relieve the gas pressure from the mechanism. Then remove the four flat head screws, BCLX3FF (fig. 8), which mount the equilibrator shaft bearing cover to the plunger end and remove the cover, B17377. Remove the two flat head screws, BCKX2CF, from the bearing retainer, A20315, and remove the retainer.

(2) Remove the nuts, BBAX1E, washers, BECX1M, and screws, BCDX1BD (fig. 12), which secure the worm bracket, C8251 (or C8252), to the top carriage. Remove the worm bracket with the worm, B17382, in place from the top carriage.

(3) Remove the cotter pin, BFA1EL (fig. 12), and nut, A20313, from the pin, A20314. Support the valve end of the equilibrator while withdrawing the fulcrum pin from the trunnion arms and the top carriage and withdraw the pin, A20314.

(4) Carefully slide the plunger end off the shaft, B7895. Remove the equilibrator to a work bench and disassemble the trunnion arm and worm wheel segment from the trunnion band by removing the nuts and lock washers from the two screws which clamp these parts together. The trunnion bearings, A20309, spacers, A20319, and cover, A20311, should remain with the other mounting parts and not be returned with the equilibrator when shipped to an arsenal for overhaul. On the plunger end the two large covers, B17377 and B17378, and bearing, A20310, will be returned to the arsenal with the equilibrator, but the retainer, A20315, should remain with the shaft, B7895, which is on the cradle.

NOTE.—Care must be exercised in the above removal that the equilibrator case, C8181 (fig. 8), is not bumped as it may permanently damage this part.

c. To assemble an equilibrator to the mount the procedures outlined above should be followed in reverse order and the equilibrator charged to the proper pressure.

d. If the equilibrator cover assembly, C53203, is to be replaced the following procedure should be followed:

NOTE.—It is essential that the plunger, C8548, is not rotated within the case, C8181, during any of these operations.

(1) Remove the equilibrator from the mount. Then remove the screws which attach the cover, C53203, to the head in the case, C8181.

(2) Slide the leather cover toward the plunger end, B17379. It will be necessary to force this cover over the pin, BFCX1FK.

(3) Remove the pin, BFCX1FK, and screw the plunger end out of the plunger. Care must be exercised that the polished surface of plunger is not marred during this operation. The screws which hold the upper end of the cover are then removed and the cover removed from the plunger end.

(4) The assembly of a new cover is accomplished by the above steps in the reverse order.

19. Cradle.—*a. Gun and equilibrators dismounted.*—(1) Remove the trunnion roller bearing housing bolts holding the left and right trunnion roller bearing housing to the top carriages.

(2) Erect a garrison gin or an improvised derrick in such a position that it will be possible to lift the cradle clear of its bearings in the top carriage and to lower it safely to the ground.

b. Rigging.—(1) When placing the rope slings around the cradle preparatory to the lift, be sure that the slings are in such a position that the cradle will remain level during its travel. The sling resting in the lifting hook of the chain block should be lashed in such a manner that the rope sling cannot slip off the hook.

(2) When the cradle is raised above its trunnion seat, remove the gear segment, C44274 (fig. 10), to prevent damage to the segment.

(3) When the cradle has been lowered to the ground, remove the left and right trunnion roller bearing housing as an assembly. Keep them free from dirt and grit. Wrap the cradle trunnion with burlap soaked in grease to prevent damage.

20. Excessive recoil.—*a.* If excessive recoil develops after a period of satisfactory performance, and a check of the gas pressure and oil supply indicates the prescribed amount, it may be assumed that either the counterrecoil valve, A21016 (fig. 5), or the recoil throttling valve, B17063, are not functioning correctly. The counterrecoil valve, A21016, may be removed and inspected for free movement of its ball, CCAX1K. Check by laying the gun at zero degrees elevation, drain the reserve oil, then remove the throttling valve recess plug, A21011,

and permit the oil to drain out level with the hole. Then remove the counterrecoil valve retainer, A21750, and back out the counterrecoil valve assembly with a long screw driver. Work the ball back and forth and note that the spring, A21014, performs its function properly.

b. In reassembling the counterrecoil valve assembly or its replacement, the threaded shoulder should be screwed lightly against its seat at the bottom of the hole in the mechanism. The use of excessive torque in seating the counterrecoil valve assembly may distort the ball cage and restrict the free movement of the ball check. Reassemble the counterrecoil valve retainer, A21750.

21. Recoil mechanism, draining and refilling recoil system.—If, for any reason, it is desired to change the oil in this mechanism the following procedure should be followed:

a. Purge the reserve oil from the mechanism.

b. Remove the plug, A21011 (fig. 5), from the cradle and allow the oil to drain out. Remove the plug, A21012 (fig. 7), from the cradle. Access to this plug is through a drilled hole in the left side frame of the top carriage near the trunnion bearing. The gun may be slightly elevated, not over 5° , to facilitate the draining. Care must be exercised that the gun is not elevated to a point where it will slide out of battery as the oil is drained, as some difficulty may be encountered in returning the gun to the in-battery position. Replace the plug, A21011, as soon as the oil stops flowing, being sure that the plug and its gasket are clean and free of dirt.

c. Using both the elevating and leveling mechanisms, depress the gun until the muzzle is definitely lower than the trunnions. This will facilitate the escape of air during the oil filling operation. Place the funnel, which has been well cleaned, in the filling hole in the cradle and fill the mechanism with heavy recoil oil. Allow all air in the mechanism to escape through the funnel as any entrapped air may adversely affect the functioning of the recoil mechanism.

d. As soon as the mechanism is entirely filled with oil, remove the funnel and replace the plug, A21012, being sure that the plug and its seat are clean and free of dirt.

e. Check the gas pressure and replenish, if necessary, to insure the floating piston being against the rear end of its cylinder and then reestablish an oil reserve of two screw fillersfull.

22. Recoil throttling valve.—a. The recoil throttling valve, B17063 (fig. 5), has been properly adjusted to permit a recoil of 31 to 32 inches when firing service weight charges at maximum elevation. The above setting will give a recoil of approximately $23\frac{1}{2}$ inches when firing service weight charges at zero degrees elevation. Any malfunction of this valve caused by improper setting, damaged parts,

or foreign matter in the system may seriously affect the recoil length and adversely affect the stability of the gun mount.

b. In case of malfunction of the recoil valve it may be disassembled for inspection and damaged parts replaced.

c. To disassemble the recoil valve purge the reserve and drain the recoil oil from the recoil system and then remove the screws, BCNX2CC (fig. 5), and cover, A21025. Back out the follower, A21002, and withdraw the recoil valve assembly. Further disassembly may now be made to replace any defective parts. The procedure for additional disassembly may be determined by examination of the assembly.

d. Assembly is effected by the procedures outlined above but in the reverse order. Care must be taken that the throttling valve stop, B17919, does not contact the end of the throttling valve, B17063, and prevent the tight seating of the follower, A21002, and gland, A9663, on filler, B12580. After the above parts are properly assembled, the valve stop, B17919, should be turned clockwise until it contacts the end of the valve, B17063. This will form a locked valve assembly, but the proper flotation or opening of the valve, B17063, should be adjusted to give a recoil of between $22\frac{1}{2}$ and $23\frac{1}{2}$ inches when firing service weight charges at zero degrees elevation. The above adjustment will give a recoil length of between 30 and 32 inches when firing service weight charges at maximum elevation. This adjustment is made by backing out (turning counterclockwise) the valve stop, B17919, until proper recoil is obtained. The exact setting of this valve must be determined by trial firings as it varies between $1\frac{1}{2}$ and $2\frac{1}{4}$ turns open in the various mechanisms. Reset the throttling valve stem packing follower, A21001, to compress the gasket, A21005, and replace the valve cover, A21025, and screws, BCNX2CC.

NOTE.—As an error of one-sixteenth of a turn in adjusting the stop will seriously affect the recoil length, care must be taken that the valve stop, B17919, does not move from its "set" position when resetting the follower, A21001.

23. Nitrogen gas leaks.—If a gas leak develops in the recuperator or equilibrator cylinder heads, bypass nuts, accessible gland in stuffing boxes, etc., it may be corrected, but not to the extent of disassembling the mechanism whereby the interior surface of the respective cylinders or the assembled pistons therein would be exposed.

24. Buffer mechanism.—In the event of failure of packing or springs within the counterrecoil buffer cylinder, the following procedure should be followed in the disassembly of the buffer mechanism:

a. Remove pipe, A146216 (fig. 6), by unscrewing the counterrecoil buffer cylinder follower, A9646, from the counterrecoil buffer cylinder head, B17058.

b. Provide a heavy clamp similar to a lath clamp dog and line it with brass or copper. Clamp it around the buffer piston extension, A9648, and have it bear against the buffer cylinder head.

c. By means of the recuperator air pressure jack (fig. 9), force the gun out of battery about $\frac{1}{2}$ inch. This will retract the recoil piston rod head, B127315 (fig. 6), and permit the buffer spring load to be taken by the clamp against the counterrecoil buffer cylinder head, B17058.

d. Remove the set screw, A9680 (fig. 6), from the rear end of the buffer cylinder and unscrew the buffer cylinder from the recoil cylinder.

e. The above procedure may be accomplished without draining the oil from the buffer or the recoil system. If only the rear packings (toward the breech of the gun when buffer is assembled to the recoil cylinder) are to be disassembled, the oil need not be drained as these packing parts are accessible, at the rear end of the buffer cylinder. If the front packings are to be removed the clamp which was assembled to the piston extension should be eased off and the piston allowed to move back slowly until it comes in contact with the end of the buffer cylinder. Remove the clamp and disassemble the packings, but do not attempt to remove the counterrecoil buffer cylinder head, B17058, until the spring pressure has been released from this part.

f. The method of disassembly of the internal parts of the buffer mechanism will have to conform to local facilities for releasing the buffer spring load. One method of accomplishing this disassembly is as follows:

(1) Remove the front packing, spring, gland, and follower.

(2) Assemble the recoil buffer spring compressor tube, A20394 (special repair tool), over the piston extension and screw it into the threads of the buffer compression ring, A9674. Place the buffer cylinder under the spindle of an arbor or drill press and compress the buffer spring. With this spring compressed the buffer cylinder head, B17058, may be removed. Next remove the pressure from the buffer spring. The internal parts may now be removed and further disassembly made as required.

NOTE.—If an arbor or drill press is not available, set the rear end of the buffer cylinder on wood blocks near some object that can be used as an anchor. Use some suitable piece of wood for a lever. Slip one end of the lever under a lip or projection on the anchor and press down on the recoil buffer spring compressor to relieve the spring load. Remove the buffer cylinder head and ease up on the lever and remove the compression ring, A9674.

g. The reverse order of operations should be carried out in reassembly. To restore the piston to its forward or in-battery position, the arbor press spindle should be applied to the rear end of the buffer

piston rod to compress the counterrecoil buffer spring, A21108, and the final position of the piston maintained by employing the clamp on the piston extension until the buffer cylinder is reassembled onto the recoil cylinder.

h. Care should be taken, when reassembling the buffer parts, that the front and rear packings are not set up too tightly. If the counterrecoil buffer cylinder packings, A9672 (fig. 6), do not fit snugly over their respective rods, or appear to be of a spongy consistency, they should be replaced with new ones of firm texture which will require some force in assembling over the rods. Leather packings, having the proper characteristics, will provide suitable sealing against oil leaks without requiring a great amount of compressing with the followers. Too much packing friction will result in a brake action on the piston rods and may stall the counterrecoil buffer spring, A21108. This would render the buffer inoperative and possibly result in damage to the matériel on the counterrecoil of the gun.

25. Malfunction of equilibrators or recoil mechanisms.—*a.* Equilibrators or recoil mechanisms which become unsatisfactory as the result of malfunction, indicating defective packing rings or other internal parts (which necessitate complete disassembly to replace), will be returned to a manufacturing arsenal for repairs.

b. In case a defective equilibrator or recoil mechanism is returned to a manufacturing arsenal for overhaul, the following external parts will accompany the mechanism:

(1) *Equilibrator.*—Shaft bearing covers, B17377 and B17378; equilibrator cover assembly, C53203; trunnion band, C4919; trunnion band lock screw, A4590; bearing, A20310; and the complete air valve assembly (figs. 8 and 12). Retainers, A20315, and screws remain with the cradle parts and the equilibrator trunnion mounting assembly (fig. 12) remains with the top carriage.

(2) *Recoil mechanism.*—(*a*) Breech operating cam in cradle extension and the gun jacking device.

(*b*) The two nuts, A9886, nut, A26930, and trunnion nut lock washer, A11628. The trunnion bearing assemblies, B124061, gear segment, C44274, and key, A36728 (fig. 15), will be removed from the cradle of the defective recoil mechanism and will remain with the gun mount for installation on the replacement cradle.

(*c*) Recoil piston rod nut, A9665, and piston rod retainer, B9816. The retainer should be properly protected by burlap wrapping before shipment.

(*d*) The elevating rack assembly and fastenings.

(*e*) The complete buffer assembly and throttling valve cover, A21025 (fig. 5).

(f) Gun wiper, A11625, oiler, oil pipes, filling plugs, name plate, etc.

(g) The equilibrator bearing shaft bracket on the cradle, with the equilibrator bearing shaft, B7895 (fig. 12), and retainers, A20315 (fig. 8.).

26. Care of equilibrators in storage.—*a.* (1) Equilibrators on gun mounts in storage or during inactive periods should be inspected every 6 months and exercised by elevating the gun several times. The effort required at 20° elevation to turn the handwheel should be noted and the equilibrator pressures replenished or adjusted as required to balance the handwheel load.

(2) Spare equilibrators are shipped to the field in an uncharged condition (no gas pressure) and with the plungers telescoped into their respective cases to obtain a minimum over-all length in the shipping crate. When uncrating these mechanisms and in the subsequent storing or assembling onto the gun mount, care should be taken to avoid rotating the plungers from their original position in the assembly.

(3) Unless spare equilibrators are to be installed immediately as replacements, they should be stored in a dry location, preferably in a storeroom having a constant cool temperature. These mechanisms will not be charged until they have been assembled in a gun mount except the partial charging required by the exercising procedure outlined below:

(*a*) In exercising stored spare equilibrators the assembly should be braced on a bench with wooden chocks and a charged (or partially charged) nitrogen cylinder hooked up in the same manner as when charging an equilibrator on a gun mount.

(*b*) Slowly charge the equilibrator until the plunger moves out to its extended position which will occur when a distance of 44 to 45 inches exists between the centers of the plunger end and equilibrator trunnion and then close the gas cylinder valve.

b. Release the gas pressure from the equilibrator and with the release valve of the filling apparatus open, manually push the plunger back into the equilibrator as far as it will go. The plunger should not be rotated in this operation, nor should it ever be extended (pulled out of the case) with the released valve open to the atmosphere.

c. Remove the gas filling equipment and tightly plug the equilibrator filling valve.

27. Care of recuperators in storage (recoil mechanism, M2).—

a. Two equally effective methods of exercising spare or inactive recuperators are described below:

(1) The gas pressure method requires the release of all existing gas-pressure in the system, permitting the gun to slide out of battery as it is elevated and thus withdrawing the recoil rod to full recoil position

if the mechanism is on a gun mount or to withdraw the rod with a tackle for exercising an unmounted recuperator. In either event, the recoil rod and floating piston are restored to their in-battery positions by recharging the gas into the mechanism.

(2) The second and preferred method requires the use of an oil pump having a reservoir capacity of about 3 gallons. In this method the gas pressure is not disturbed, the oil reserve being purged and the special pump connected to the system in a manner similar to the oil screw filler with the gun at zero degrees elevation. The union on the special pump tubing for connecting into the oil filling valve of recuperator is designed so that it will lift and hold the oil check valve off its seat. The pump reservoir initially contains about 2 gallons of recoil oil. With the pump release valve open, the gun should be elevated until it slides out of battery thereby forcing the recoil cylinder oil into the pump reservoir. After the gun has reached full recoil position it is returned to battery by closing the pump release valve and then operating the pump lever until only the original amount of oil remains in the reservoir. From this point the operation of the pump is continued until about 160 cubic inches of the original reservoir oil has entered the system and has forced the floating piston away from its seat to a position approximating full recoil. The pump release valve is again opened and the gas pressure forces the floating piston back to its seated position and thus restores the oil in reservoir to the original 2 gallons. The gun is then depressed to horizontal, the pump disconnected, and the reserve oil charged into the system in the usual manner.

b. In the event that the recuperator is an unmounted spare unit a tackle for pulling out the recoil rod will be required as in the gas exercising method first described. The special pump now under consideration for this type of exercise will be equipped with an instruction plate indicating the stroke delivery in cubic inches in order that the pump operator will have knowledge of the quantity of oil being forced into the mechanism after the gun is in battery.

28. Armature and magnet.—a. When replacing or refacing an armature the following procedure should be followed:

(1) Place a jack under the axle and jack the wheel affected clear of the ground.

(2) Remove the hub cap. Remove the jam nut, A146158 (figs. 13 and 14). Remove the lock ring and adjusting nut assembly.

(3) Pull off the disk, rim wheel, and hub assembly from the axle.

(4) Place the inner roller bearing in hub of wheel as indicated in figure 11, block armature out against stops at (3).

(5) Place short end of outer posts (1) against magnet face, slide center pin against axle at (A), tighten thumbscrew (5) on frame, slide collar (8) against frame, and tighten the thumbscrew.

(6) Set the disk and rim wheel in such a position that the armature will just touch the long ends of the outer posts at (4), loosen thumbscrew (5) on frame, slide the center pin till it touches on the inner roller bearing shoulder (7), tighten thumbscrew (5).

b. The distance (D) from the collar to the frame is the distance the armature is depressed; if this distance is greater than $\frac{5}{32}$ inch, shim bearing out at location A; if under $\frac{1}{8}$ inch, shim out armature ring at (B).

c. In assembling, do not allow grease, however slight, to touch any part of the brake. Grease will cause grabbing, locking, or loss of power. Bearing must be hand packed with wheel-bearing grease.

d. Mount the disk and rim wheel on the axle and set up on the adjusting nut, A146159 (figs. 13 and 14), until the wheel revolves without loose bearing or backlash. Set up the jam nut, A146158, tight and assemble the hub cap and its gasket.

29. Greasy brake lining.—Proceed as outlined in paragraph 28 a (1), (2), and (3). Remove the brake band spring. Expand the brake band and remove it. Assemble a new brake band assembly and proceed in assembling in the reverse order of disassembly.

30. Glazed magnet facing.—The facing of the magnet may become glazed. This is not characteristic of the facing, but from some foreign substance imbedding itself into the matériel a polished surface may result. This will have a tendency to reduce the effectiveness of the brake. To remedy cases of this kind a light cut may be taken in a lathe across the facing of the magnet, or the facing of the magnet may be roughened with coarse emery cloth. Care must be taken not to cut the pole face down.

31. Worn-out brakes.—Brake lining may be worn to the full extent of the magnet travel. Replace brake band assembly as outlined in paragraph 29.

32. Worn wheel bearings.—a. Worn wheel bearing or loose wheels will cause erratic action of the brakes and can be evidenced by the wide track the pole face of the magnet makes on the armature. Wheel hubs may be cracked or broken.

b. When one or more of the above malfunctions take place the wheel must be disassembled and new parts assembled.

33. Brake drums out of round or scored.—Remove the disk and rim wheel and proceed as outlined in paragraph 28a (1), (2), and (3). Bore out drum concentric with the inside of the hub.

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34. Bushing in magnet worn out.—Replace with a new magnet as old part will be badly worn.
35. Warped backing plate.—If plate is bent out of shape beyond repair, replace with new plate.

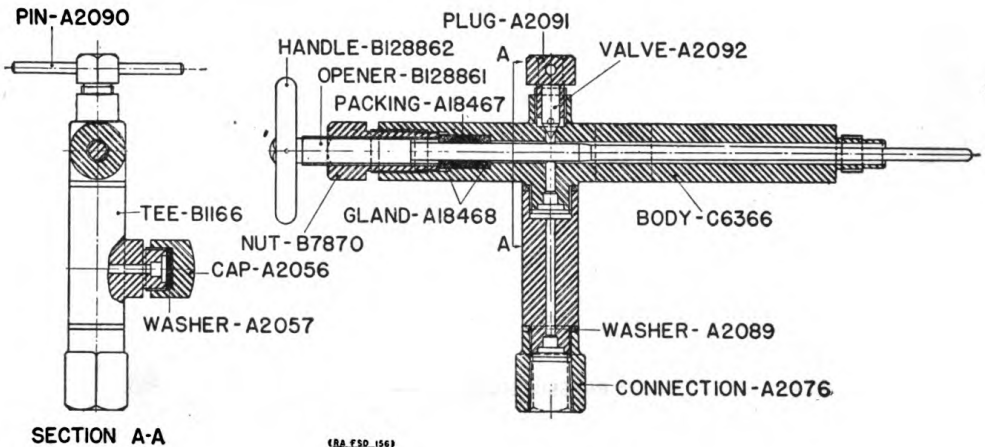


FIGURE 1.—Tube, filling, air.

Reference	Item	Reference	Item
C6366	Body, air filling tube.	A2090	Pin.
A2056	Cap, tee.	A2091	Plug.
A2076	Connection.	B1166	Tee.
A18468	Gland, valve opener packing.	A2092	Valve.
B128862	Handle, valve opener.	A2057	Washer, chrome lea., 3/4 diam. by 0.1 thick.
B7870	Nut, valve opener.	A2089	Washer, cop., 0.76 I. D. by 1 O. D. by 0.1 thick.
B128861	Opener, valve.		
A18467	Packing, valve opener.		

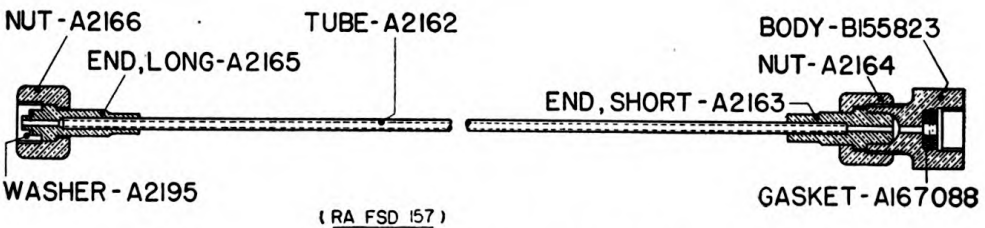


FIGURE 2.—Tube, filling, air, flexible.

Reference	Item	Reference	Item
B155823	Body.	A167088	Gasket.
A2165	End, tube, long.	A2164	Nut, union, 5/8-14 Whit.
A2163	End, tube, short.	A2166	Nut, union, 3/4-16NF-2.
A2162	Tube, cop., 1/8 I. D. by 3/16 O. D. by 72 long.	A2195	Washer, lea., 1/4 by 3/16 by 1/16 thick.

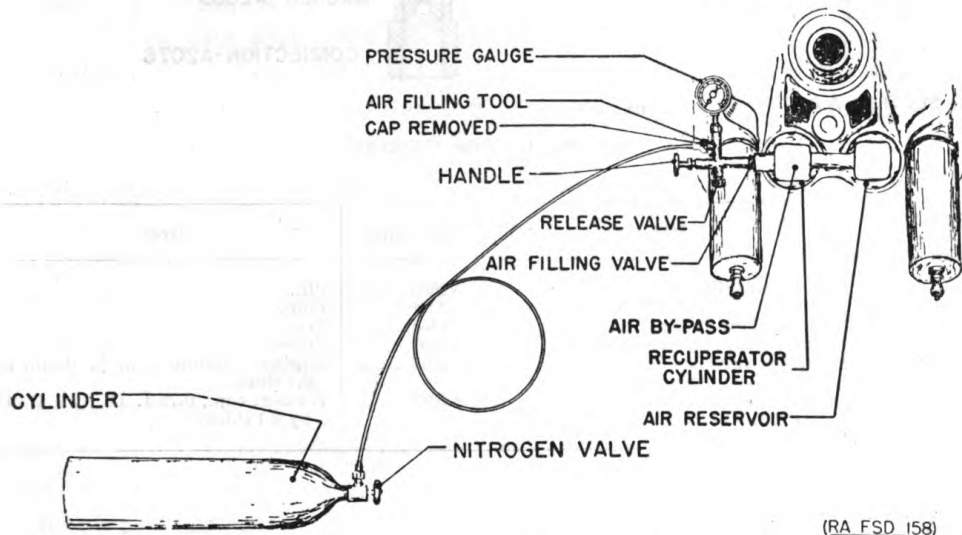


FIGURE 3.—Method of replenishing air in recuperator.

(RA FSD 158)

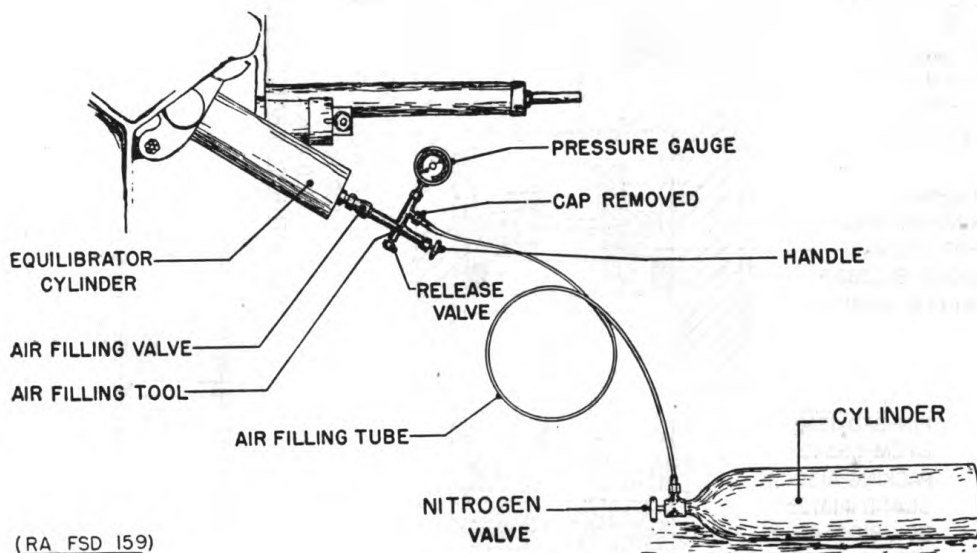


FIGURE 4—Method of replenishing air in equilibrator.

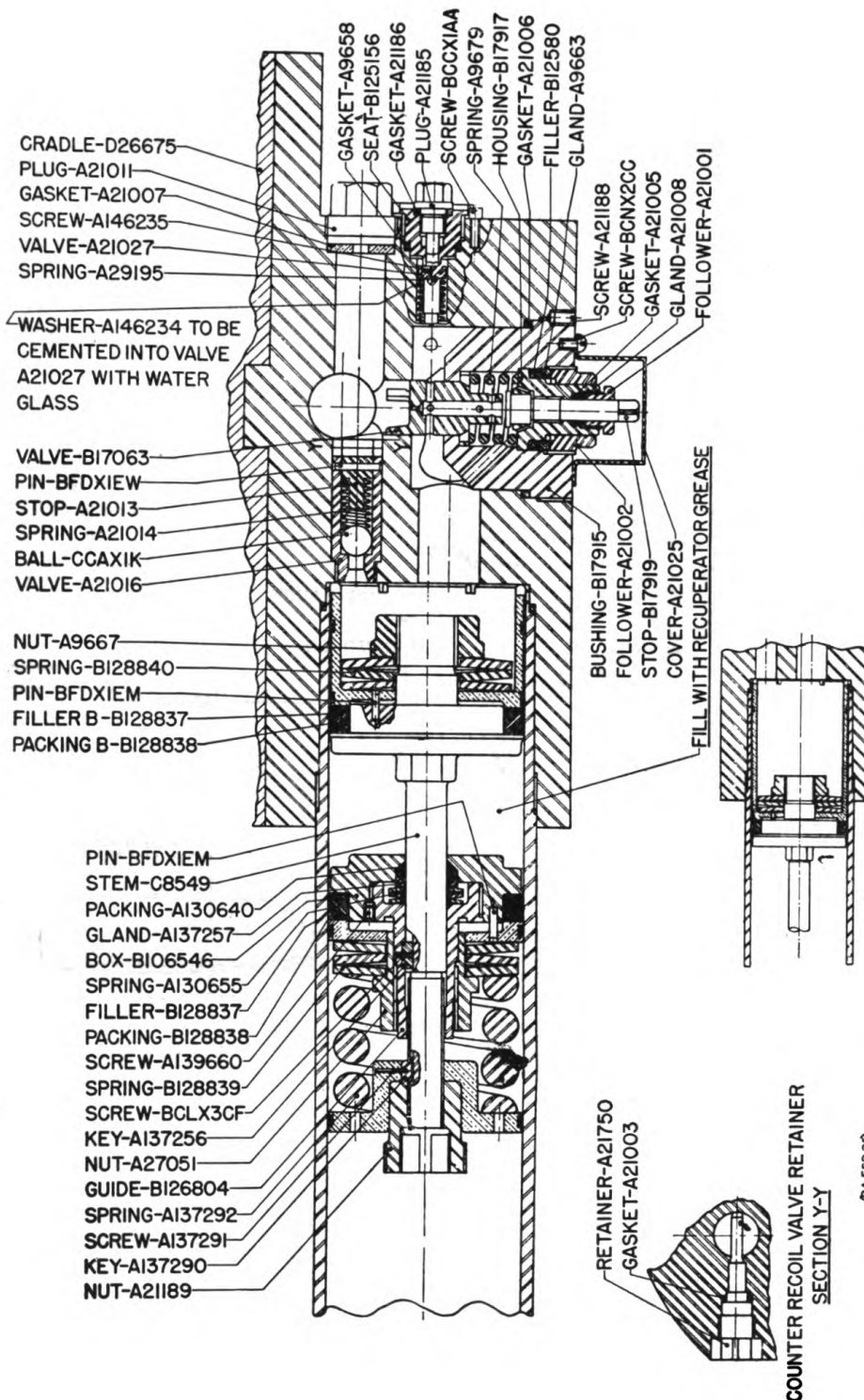


FIGURE 5.—Floating piston and throttling valve, assembly—sectioned views.

Reference	Item	Reference	Item
CCAX1K.....	Ball, chr-alloy-S., grade 2, $\frac{3}{4}$ in.	BFDX1EM..	Pin, stght., S., $\frac{3}{16}$ by $\frac{3}{4}$.
B106546.....	Box, floating piston stuffing.	BFDX1EW..	Pin, stght., S., $\frac{3}{16}$ by $1\frac{1}{2}$.
B17915.....	Bushing, recoil valve.	A21185.....	Plug, filling valve seat.
A21025.....	Cover, throttling valve.	A21011.....	Plug, throttling valve recess.
D26675.....	Cradle (welded construction).	A21750.....	Retainer, counterrecoil valve.
B12580.....	Filler, packing, 1.533 I. D., 2.008 O. D. (lead).	B125156.....	Seat, filling valve, rear.
B128837.....	Filler, packing, $3\frac{3}{4}$ I. D., $4\frac{1}{4}$ O. D.	A146235.....	Screw, cap, fl-fil-hd., $\frac{1}{8}$ -44NF-2 by $\frac{5}{16}$.
A21002.....	Follower, throttling valve packing.	BCCX1AA...	Screw, cap, oval-fil-hd., $\frac{1}{4}$ -20NC-2 by $\frac{3}{4}$.
A21001.....	Follower, throttling valve stem packing.	A139660.....	Screw, floating piston stem guide.
A21005.....	Gasket, $\frac{1}{2}$ I. D., 0.79 O. D., 0.2 thick, tapered 10° .	A21188.....	Screw, hdls., fl-pt., S., $\frac{3}{8}$ -16NC-2 by $\frac{1}{2}$.
A21007.....	Gasket, cop., $\frac{3}{8}$ I. D., 1.655 O. D., $\frac{3}{16}$ thick.	A137291.....	Screw, key retaining.
A9658.....	Gasket, cop., $1\frac{1}{8}$ I. D., 1.372 O. D., $\frac{3}{16}$ thick.	BCLX3CF...	Screw, mach., fl-hd., cor-res-S., No. 2 (0.086)-64NF-3 by $\frac{3}{8}$.
A21003.....	Gasket, cop., $\frac{1}{2}$ I. D., 0.78 O. D., $\frac{1}{8}$ thick.	BCNX2CC...	Screw, mach., rd-hd., S., $\frac{1}{4}$ -20NC-2 by $\frac{3}{8}$.
A21186.....	Gasket, cop., 0.66 I. D., $\frac{7}{8}$ O. D., $\frac{3}{16}$ thick.	A130655.....	Spring, Belleville, 1.055 by 1.845 by 0.12 by 0.17.
A21006.....	Gasket, cop., 4 I. D., 4.4 O. D., $\frac{3}{16}$ thick.	B128839.....	Spring, Belleville, 1.57 by 4.23 by 0.23 by 0.316 by 0.086.
A21008.....	Gland, br., $\frac{1}{2}$ I. D., 0.79 O. D., 0.2 thick.	B128840.....	Spring, Belleville, 1.97 by 4.58 by 0.23 by 0.332.
A9663.....	Gland, br., 1.534 I. D., 2.006 O. D., 0.28 thick, beveled 6° .	A21014.....	Spring, compression, 0.0625 diam. stock, 0.7 O. D., 9 coils.
A137257.....	Gland, floating piston stem.	A29195.....	Spring, filling valve.
B126804.....	Guide, floating piston stem.	A137292.....	Spring, grease compression.
B17917.....	Housing, throttling valve stop.	A9679.....	Spring, throttling valve.
A137290.....	Key.	C8549.....	Stem, floating piston.
A137256.....	Key, floating piston stem.	B17919.....	Stop, throttling valve.
A9667.....	Nut, floating piston.	A21013.....	Stop, valve.
A21189.....	Nut, floating piston stem.	A21016.....	Valve, counterrecoil.
A27051.....	Nut, floating piston stem guide.	A21027.....	Valve, filling.
B128838.....	Packing, $4\frac{1}{8}$ I. D., $4\frac{3}{4}$ O. D.	B17063.....	Valve, throttling.
A130640.....	Packing, floating piston stem.	A146234.....	Washer, lea., $\frac{1}{8}$ I. D. by $\frac{3}{16}$ O. D. by $\frac{7}{32}$ thick.

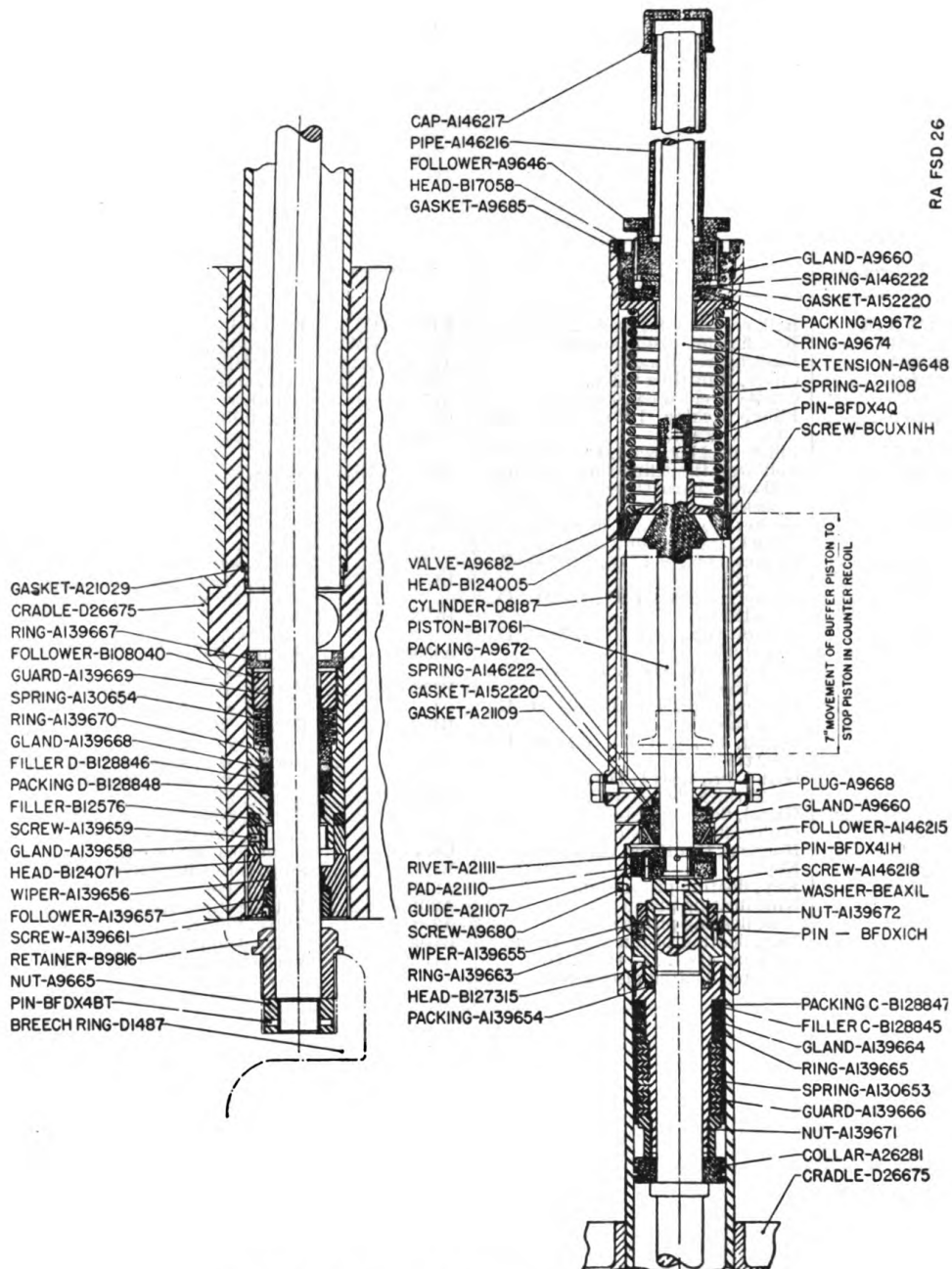
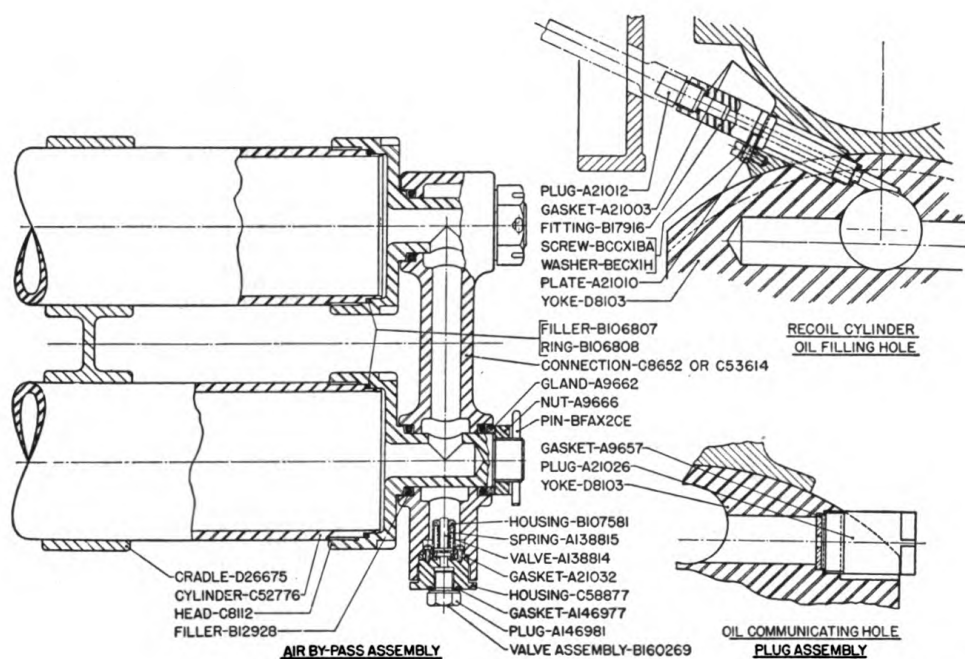


FIGURE 6.—Recoil cylinder, assembly—sectioned views.

Reference	Item	Reference	Item
A146217	Cap, pipe, br., 1¼ in.	B128847	Packing, recoil piston, large (lea.).
A26281	Collar, recoil piston rod.	A139654	Packing, recoil piston, small (lea.).
D26675	Cradle (welded construction).	A21110	Pad, rawhide.
D8187	Cylinder, counterrecoil buffer.	BFDX4Q	Pin, stght., S., 0.118 by 1¼.
A9648	Extension, piston.	BFDX4.1H	Pin, stght., S., 0.120 by 2¾.
B12576	Filler, packing, recoil stuffing box.	BFDX1CH	Pin, stght., S., ¼ by ¾.
B128846	Filler, packing, recoil stuffing box (rubber).	BFDX4BT	Pin, stght., S., ¾ by 2¼.
B128845	Filler, recoil piston packing (rubber).	A146216	Pipe, oil, br., 1¼ by 7½.
A9646	Follower, counterrecoil buffer cylinder.	B17061	Piston, counterrecoil buffer.
A146215	Follower, counterrecoil buffer stem packing.	A9668	Plug, filling and drain.
A139657	Follower, piston rod wiper.	B9816	Retainer, piston rod.
B108040	Follower, recoil stuffing box spring.	D1487	Ring, breech.
A21109	Gasket, cop., ¾ I. D., 1¼ O. D., ¼ thick.	A139665	Ring, compression.
A9685	Gasket, cop., 3.521 I. D., 3.750 O. D., ¾ thick.	A139670	Ring, compression.
A152220	Gasket, counterrecoil buffer, cylinder packing spring.	A9674	Ring, compression, counterrecoil buffer spring.
A21029	Gasket, recoil cylinder (cop.).	A139663	Ring, recoil cylinder wiper (bz.).
A9660	Gland, counterrecoil buffer, cylinder follower packing.	B139667	Ring, recoil stuffing box supporting.
A139668	Gland, packing, recoil stuffing box.	A21111	Rivet, cop., fl.-hd., 0.12 by 2½.
A139664	Gland, recoil piston packing (bz.).	A146218	Screw, recoil piston rod head lock.
A139653	Gland, recoil stuffing box.	A139659	Screw, recoil stuffing box gland.
A139666	Guard, Belleville spring.	A9680	Screw, set, hdls., dog-pt., S., ¼-28NF-2 by ¾ over-all.
A139669	Guard, Belleville spring.	BCUX1NH	Screw, set, hdls., fl.-pt., br., No. 10 (0.190)-32NF-3 by ¾.
A21107	Guide, piston.	A139661	Screw, set, recoil cylinder rear head.
B17058	Head, counterrecoil buffer cylinder.	A130654	Spring, Belleville, 1.51 by 2.43 by 1.055 by 0.155.
B124005	Head, piston.	A130653	Spring, Belleville, 1.790 by 2.6 by 1.137 by 0.074.
B124071	Head, recoil cylinder, rear.	A21108	Spring, counterrecoil buffer.
B127315	Head, recoil piston rod.	A146222	Spring, counterrecoil buffer cylinder head packing.
A139671	Nut, recoil piston packing spring compression.	A9682	Valve, counterrecoil buffer.
A9665	Nut, recoil, piston rod.	BEAX1L	Washer, lock, "Shakeproof No. 12 type," ¾ in.
A139672	Nut, wiper.	A139656	Wiper, piston rod (lea.).
B128848	Packing, recoil stuffing box (lea.).	A139655	Wiper, recoil cylinder.
A9672	Packing, counterrecoil buffer cylinder (lea.).		



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FIGURE 7.—Air by-pass, assembly and oil communicating hole plug, assembly—sectioned views.

Reference	Item	Reference	Item
C8652.....	Connection, air-pass.	C8112.....	Head, recuperator cylinder.
D26675.....	Cradle (welded construction).	C58877.....	Housing, air filling valve plug.
C52776.....	Cylinder, air reservoir.	B107581.....	Housing, air valve spring.
B106807.....	Filler, packing, 4.935 I. D. by 5.22 O. D. by $\frac{3}{16}$ thick (lead).	A9666.....	Nut, recuperator cylinder head.
B12928.....	Filler, packing, 1.85 I. D., 2 O. D. (rubber).	BFA X2CE ..	Pin, cotter, split, S., $\frac{1}{4}$ by $2\frac{3}{4}$.
B17916.....	Fitting, oil filling.	A21010.....	Plate, locking.
A146977.....	Gasket, air filling valve plug hous- ing.	A146981.....	Plug, air filling valve plug housing.
A9657.....	Gasket, cop., $\frac{3}{8}$ I. D., $1\frac{1}{2}\frac{3}{16}$ O. D., $\frac{3}{16}$ thick.	A21012.....	Plug, filling, oil.
A21003.....	Gasket, cop., $\frac{1}{2}$ I. D., 0.78 O. D., $\frac{1}{8}$ thick.	A21026.....	Plug, oil communicating hole.
A21032.....	Gasket, cop., $1\frac{3}{8}$ I. D., 1.65 O. D., $\frac{3}{16}$ thick.	B106808.....	Ring, cup, cop., 4.935 I. D. by 5.22 O. D.
A9662.....	Gland, br., 1.85 I. D., 2.38 O. D., 0.28 thick.	BCCX1BA ..	Screw, cap, oval-fl-hd., $\frac{5}{16}$ -18NC- 2 by $\frac{3}{4}$.
		A138815.....	Spring, air filling valve.
		B106269.....	Valve, air filling, assembly.
		A138814.....	Valve, air filling.
		BE CX1H.....	Washer, lock, reg., $\frac{5}{16}$ by $\frac{1}{8}$ by $\frac{1}{16}$.
		D8103.....	Yoke, cradle.

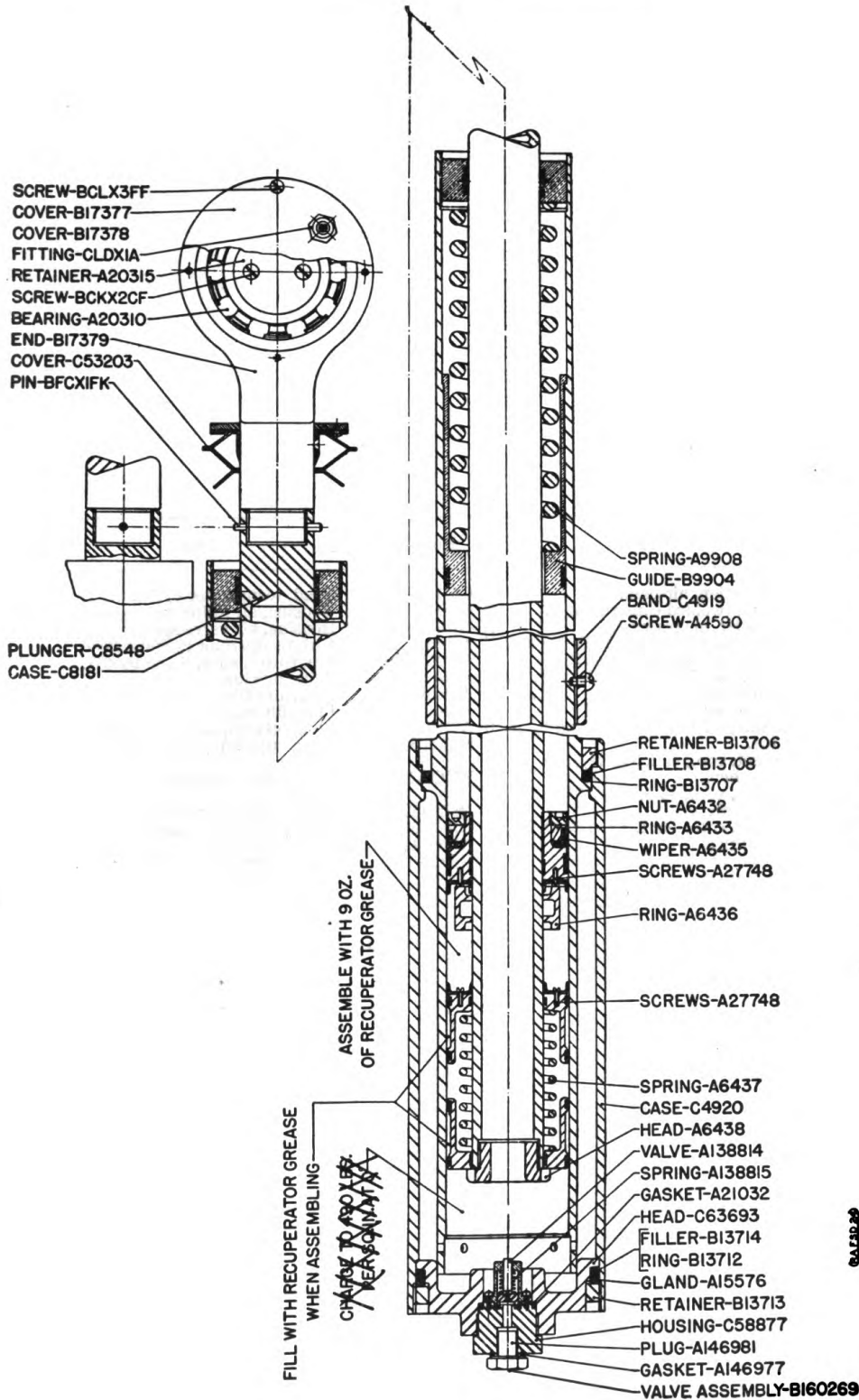


Figure 8.—Equilibrator, assembly—sectioned views.

Reference	Item	Reference	Item
C4919.....	Band, equilibrator trunnion.	BFCX1FK...	Pin, taper, No. 4, 0.25 by 2½.
A20310.....	Bearing, ball, double row, radial, self-aligning, 2.1654 bore, 4.7244 O. D., 1.1417 width.	A146981.....	Plug, air filling valve plug housing.
C4920.....	Case, equilibrator, lower.	C8548.....	Plunger, equilibrator.
C8181.....	Case, equilibrator, upper.	A20315.....	Retainer, equilibrator arm bearing.
C53203.....	Cover, equilibrator, group assembly.	B13713.....	Retainer, lower, 4½ by 5¾ by 0.72 thick.
B17378.....	Cover, equilibrator shaft bearing (inner).	B13706.....	Retainer, upper, 4¾ by 4.872 by 1½ thick.
B17377.....	Cover, equilibrator shaft bearing (upper).	B13707.....	Ring, cup, cop., 4¾ by 4¾ by 0.065 cup.
B17379.....	End, equilibrator plunger.	B13712.....	Ring, cup, cop., 4¾ by 5¼ by 0.07 cup.
B13708.....	Filler, lead, ¼ by 4¾ by 4¾.	A6433.....	Ring, equilibrator grease seal packing.
B13714.....	Filler, lead, 4¾ by 5¼.	A6436.....	Ring, stop, floating, equilibrator.
CLDX1A.....	Fitting, lubr., b-hd. type, stght., ½-27NPT, male.	A4590.....	Screw, equilibrator trunnion band.
A146977.....	Gasket, air filling valve plug housing.	A27748.....	Screw, mach., fl-hd., S., 0.125-40NC-2 by ¾.
A21032.....	Gasket, cop., 1¾ I. D. by 1.65 O. D. by ¾ thick.	BCLX3FF...	Screw, mach., fl-hd., cor-res-S., No. 10 (0.190)-32NF-3 by ¾.
A15576.....	Gland, bz., 4¾ I. D., 5¼ O. D., 0.18 thick.	BCKX2CF...	Screw, mach., fl-hd., S., ¼-20NC-2 by ¾.
B9904.....	Guide, equilibrator upper spring.	A138815.....	Spring, air filling valve.
C63693.....	Head, equilibrator lower case.	A6437.....	Spring, equilibrator, lower.
A6438.....	Head, equilibrator plunger.	A9908.....	Spring, equilibrator, upper.
C58877.....	Housing, air filling valve plug.	A138814.....	Valve, air filling.
A6432.....	Nut, equilibrator grease seal packing.	B160269.....	Valve, air filling, assembly.
		A6435.....	Wiper, lea., bore 2¾, O. D. 3½, cup ¾.

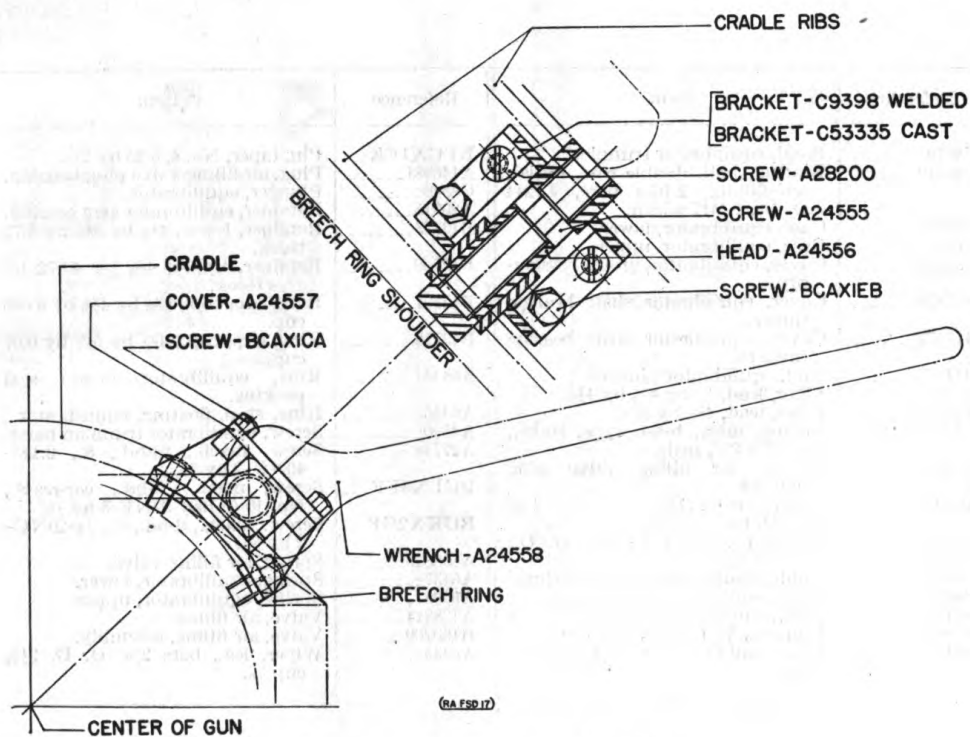


FIGURE 9.—Jacking device—sectioned views.

Reference	Item	Reference	Item
C9398.....	Bracket, recuperator air checking (welded construction).	A28200.....	Screw, cap, fl-hd., S., $\frac{1}{4}$ -13NC-2 by $1\frac{1}{8}$."
C53335.....	Bracket, recuperator air checking (steel casting).	BCAX1CA....	Screw, cap, hex-hd., $\frac{3}{8}$ -16NC-2 by $\frac{3}{4}$."
A24557.....	Cover, jack recuperator check bracket.	BCAX1EB....	Screw, cap, hex-hd., $\frac{1}{4}$ -13NC-2 by $\frac{7}{8}$."
A24556.....	Head, jack recuperator check screw.	A24555.....	Screw, jack recuperator check.
		A24558.....	Wrench, gun jacking device.

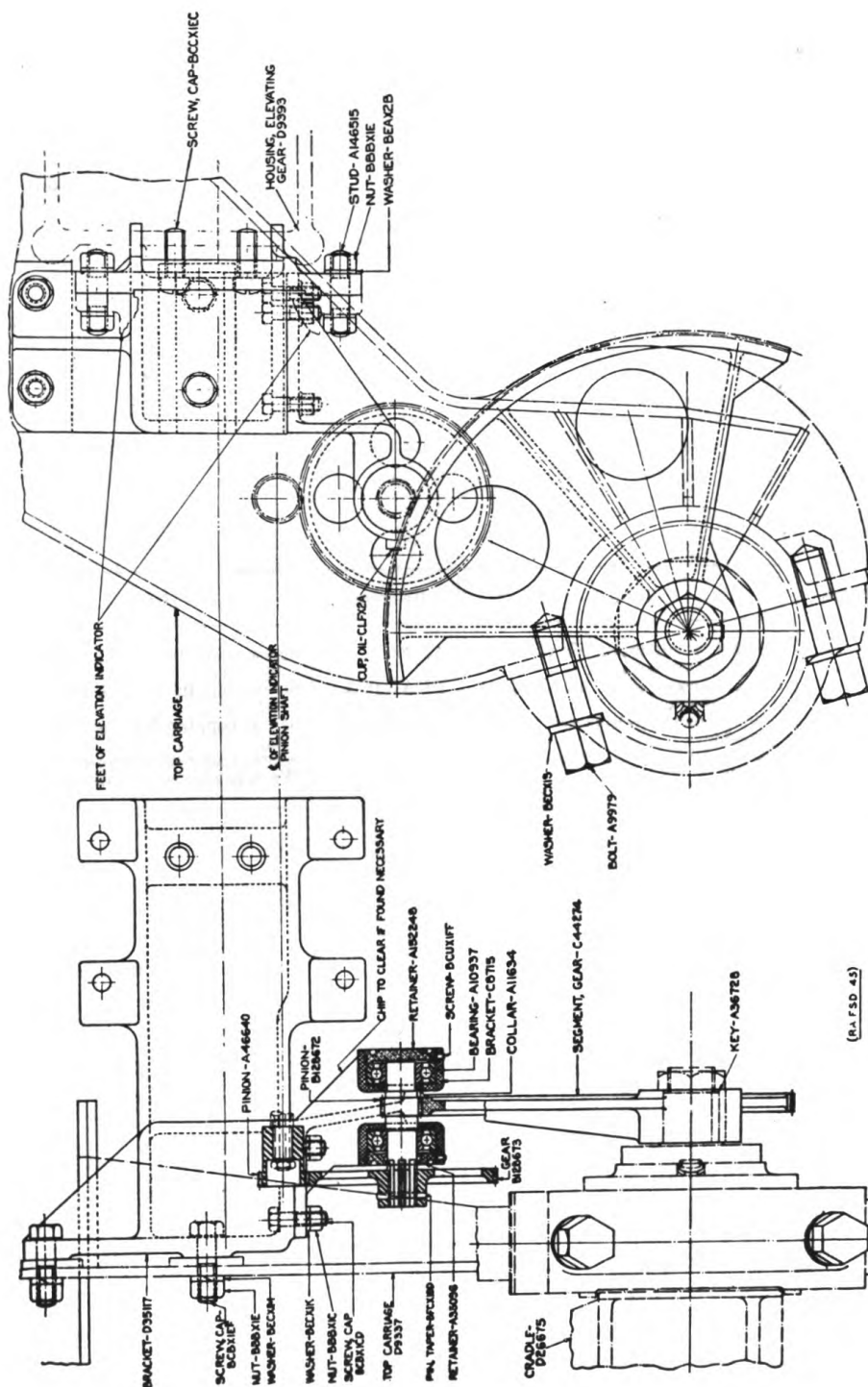


FIGURE 10.—Elevation indicator drive and mounting, assembly—sectioned view.

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Reference	Item	Reference	Item
A10937.....	Bearing, ball, single row, plain radial, 0.7874 bore, 1.8504 O.D., 0.5512 width.	A46640.....	Pinion, spur.
A9979.....	Bolt, trunnion roller bearing housing.	A35096.....	Retainer.
D35117.....	Bracket, elevating indicator.	A152248.....	Retainer.
C8715.....	Bracket, elevating segment spur pinion.	BCBX1CD.....	Screw, cap, hex-hd., $\frac{3}{8}$ -24NF-2 by $\frac{1}{4}$.
D9337.....	Carriage, top (welded construction).	BCBX1EF.....	Screw, cap, hex-hd., $\frac{1}{4}$ -20NF-2 by $\frac{1}{4}$.
A11634.....	Collar, elevating segment spur pinion.	BCCX1EC.....	Screw, cap, oval-fil-hd., $\frac{1}{2}$ -13NC-2 by 1.
D26675.....	Cradle (welded construction).	BCUX1FF.....	Screw, set, hdis., fl-pt., cor-res-S., No. 10 (0.190)-32NF-3 by $\frac{1}{4}$.
CLFX2A.....	Cup, oil, drive type, $\frac{1}{4}$ in. diam.	C44274.....	Segment, gear.
B128673.....	Gear, spur, elevating segment.	A146515.....	Stud, $\frac{1}{2}$ -20NF-2 by $2\frac{1}{4}$.
D9393.....	Housing, elevating gear.	BE CX1K.....	Washer, lock, reg., $\frac{3}{8}$ by $\frac{1}{8}$ by $\frac{3}{32}$.
A36728.....	Key, 0.377 sq. by $1\frac{1}{8}$.	BE CX1M.....	Washer, lock, reg., $\frac{1}{2}$ by $1\frac{1}{64}$ by $\frac{3}{8}$.
BBBX1C.....	Nut, reg., hex., s-fin., $\frac{3}{8}$ -24NF-2.	BE CX1S.....	Washer, lock, reg., $\frac{7}{8}$ by $1\frac{1}{64}$ by $\frac{3}{16}$.
BBBX1E.....	Nut, reg., hex., s-fin., $\frac{1}{2}$ -29NF-2.	BE AX2B.....	Washer, lock, "Shakeproof No. 12 type," $\frac{1}{2}$ in.
BFCX1BD.....	Pin, taper, No. 0, 0.156 by $\frac{1}{4}$.		
B128672.....	Pinion, elevating segment spur.		

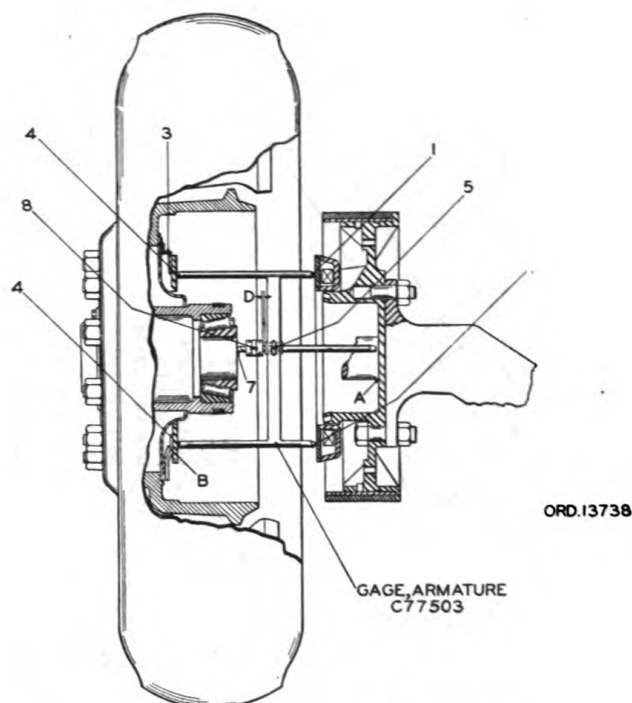


FIGURE 11.—Armature gage—sectioned view.

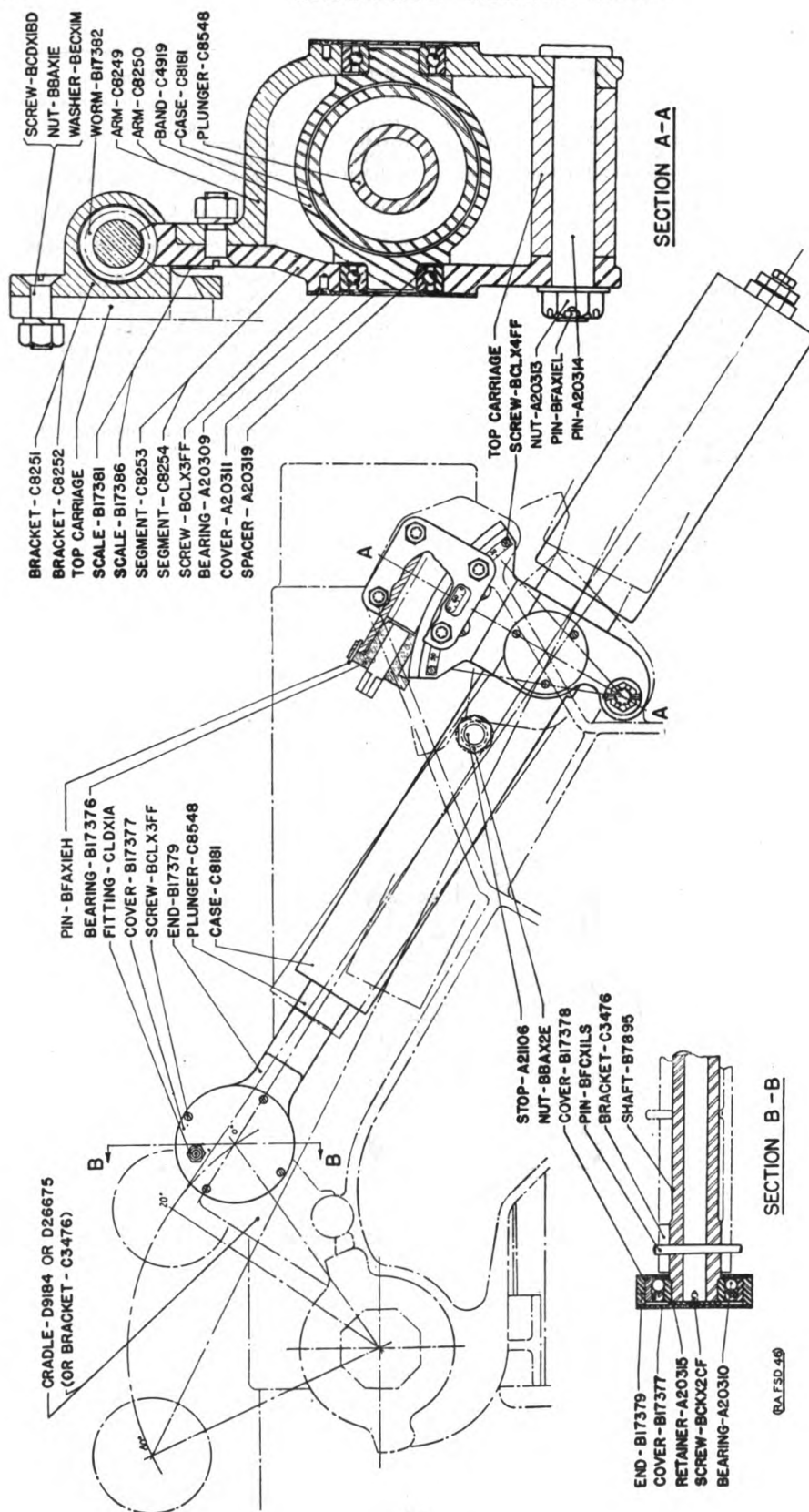
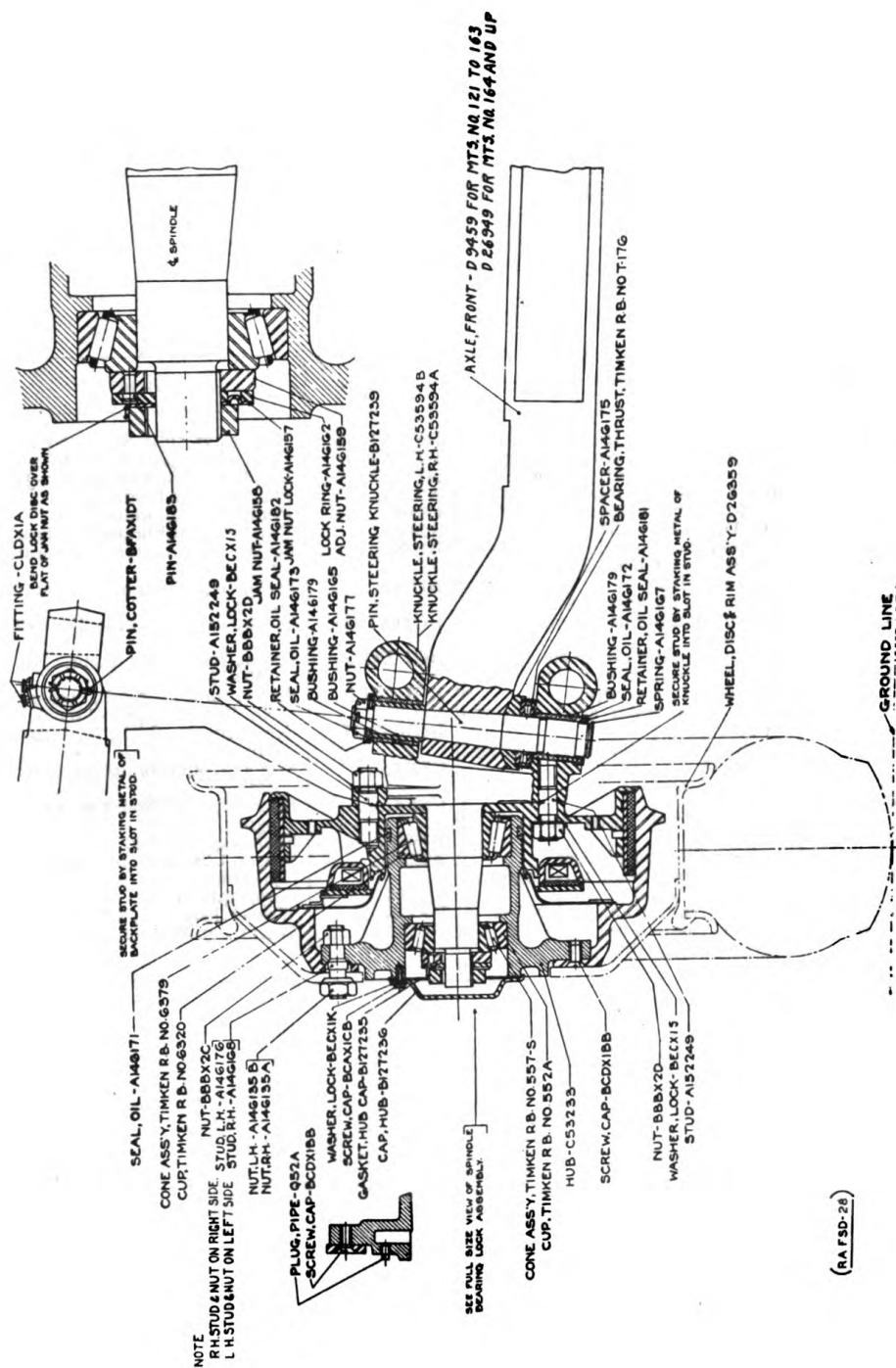


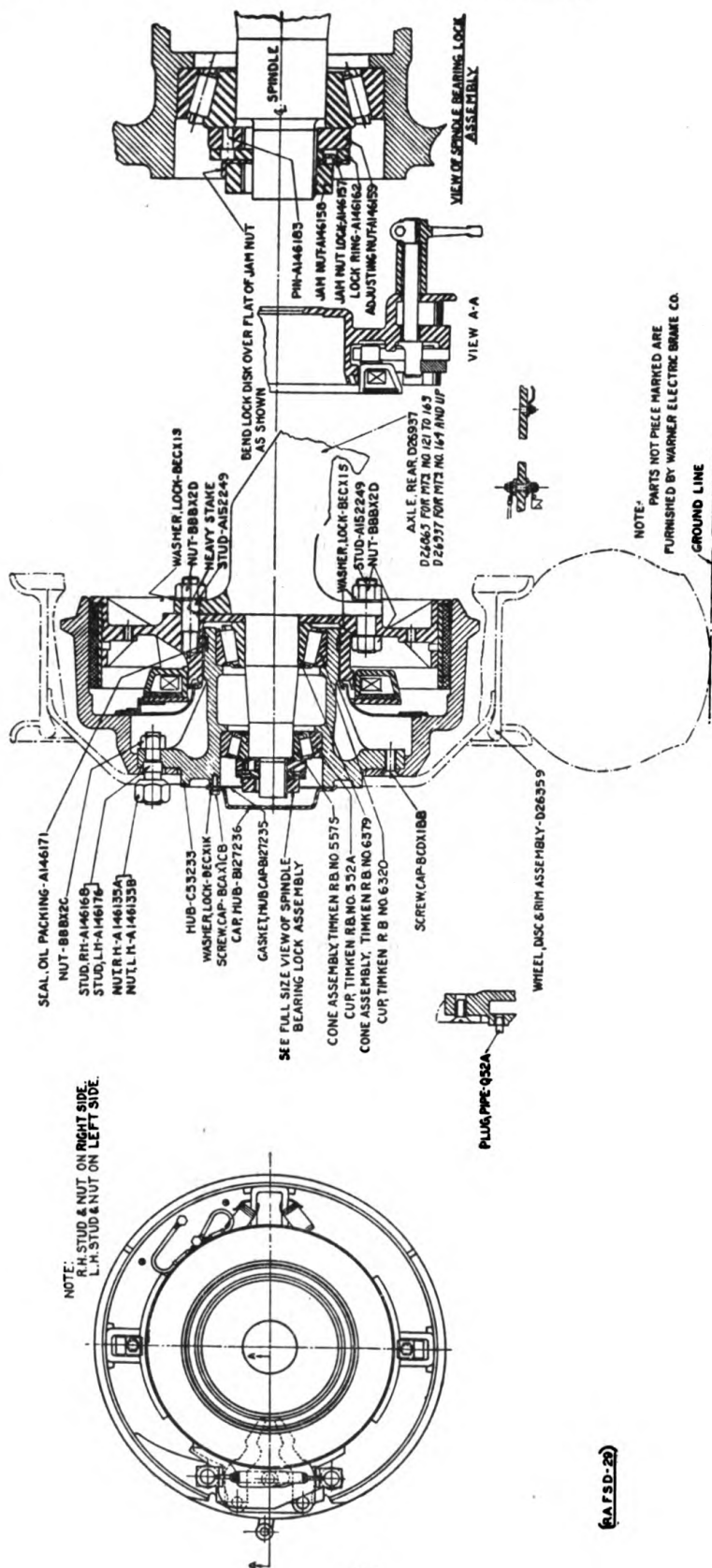
FIGURE 12.—Equilibrator mounting, assembly—sectioned view.

3-INCH ANTI-AIRCRAFT GUN MATÉRIEL

Reference	Item	Reference	Item
C8249.....	Arm, equilibrator trunnion, left.	BFAX1EH...	Pin, cotter, split, S., $\frac{5}{32}$ by $1\frac{1}{4}$.
C8250.....	Arm, equilibrator trunnion, right.	BFAX1EL...	Pin, cotter, split, S., $\frac{5}{32}$ by $1\frac{3}{4}$.
C4919.....	Band, equilibrator trunnion.	BFCX1LS...	Pin, taper, No. 8 (0.492) by $4\frac{1}{4}$.
A20310.....	Bearing, ball, double row, radial, self-aligning, 2.1654 bore, 4.7244 O. D., 1.1417 width.	A20314.....	Pin, trunnion fulcrum.
A20309.....	Bearing, ball, single row, plain radial, 1.1811 bore, 2.4409 O. D., 0.6299 width.	C8548.....	Plunger, equilibrator.
B17376.....	Bearing, equilibrator worm.	A20315.....	Retainer, equilibrator arm bearing.
C3476.....	Bracket, equilibrator plunger bearing shaft.	B17386.....	Scale, equilibrator temperature, left.
C8252.....	Bracket, equilibrator worm, left.	B17381.....	Scale, equilibrator temperature, right.
C8251.....	Bracket, equilibrator worm, right.	BCDX1BD...	Screw, cap, fl-hd., $\frac{1}{2}$ -13NC-2 by $1\frac{3}{4}$.
C8181.....	Case, equilibrator, upper.	BCLX4FF...	Screw, mach., fl-hd., br., No. 10, 0.190-32NF-3 by $\frac{3}{4}$.
B17378.....	Cover, equilibrator shaft bearing (inner).	BCLX3FF...	Screw, mach., fl-hd., cor-res-S., No. 10, 0.190-32NF-3 by $\frac{3}{4}$.
B17377.....	Cover, equilibrator shaft bearing (upper).	BCKX2CF...	Screw, mach., fl-hd., S., $\frac{1}{4}$ -20NC-2 by $\frac{1}{2}$.
A20311.....	Cover, trunnion bearing.	C8253.....	Segment, equilibrator worm wheel, left.
D26675.....	Cradle (welded construction).	C8254.....	Segment, equilibrator worm wheel, right.
D9184.....		B7895.....	Shaft, equilibrator.
B17379.....	End, equilibrator plunger.	A20319.....	Spacer, 1.285 I. D. by $1\frac{5}{8}$ O. D. by $\frac{1}{16}$ thick.
CLDX1A.....	Fitting, lubr., b-hd. type, stght., $\frac{1}{8}$ -27NPT, male.	A21106.....	Stop, equilibrator.
BBAX1E.....	Nut, reg., hex., s-fin., $\frac{1}{2}$ -13NC-2.	BECX1M.....	Washer, lock, reg., $\frac{1}{2}$ by $1\frac{1}{4}$ by $\frac{1}{8}$.
BBAX2E.....	Nut, reg., hex., s-fin., 1-8NC-2.	B17382.....	Worm, equilibrator (bz.).
A20313.....	Nut, washer, $\frac{3}{4}$ -10NC-2.		



Reference	Item	Reference	Item
D9459.....	Axle, front (for mounts Nos. 121 to 163, incl.).	BBBX2D.....	Nut, reg., hex., s-fin., $\frac{7}{8}$ -14NF-2.
D26949.....	Axle, front (for mounts Nos. 164 and up).	A146177.....	Nut, steering knuckle pin.
TRB176.....	Bearing, roller, thrust, bore 1.760, O. D. 3.266, thickness 0.9375.	BFA X1DT.....	Pin, cotter, split, S., $\frac{1}{8}$ by 2.
A146165.....	Bushing, front bogie steering knuckle, upper, inner.	A146183.....	Pin, S., 0.254 by $\frac{1}{16}$.
A146179.....	Bushing, front bogie steering knuckle, upper, outer.	B127239.....	Pin, steering knuckle.
B127236.....	Cap, disk and rim wheel hub.	Q52A.....	Plug, pipe, M. I., sq-hd., $\frac{1}{8}$ in.
TRB6379.....	Cone and roller, taper roller bearing, large, assembly.	A146181.....	Retainer, front bogie steering knuckle lower oil seal.
TRB557-S.....	Cone and roller, taper roller bearing, small, assembly.	A146182.....	Retainer, front bogie steering knuckle upper oil seal.
TRB6320.....	Cup, taper roller bearing, large.	A146162.....	Ring, lock.
TRB552A.....	Cup, taper roller bearing, small.	BCDX1BB.....	Screw, cap, fl-hd., $\frac{1}{2}$ -12NC-2 by $1\frac{1}{4}$.
CLDX1A.....	Fitting, lubr., b-hd. type, stght., $\frac{1}{8}$ -27NPT, male.	BCAX1CB.....	Screw, cap, hex-hd., $\frac{3}{8}$ -24NF-2 by $\frac{7}{8}$.
B127235.....	Gasket, disk and rim wheel hub cap.	A146172.....	Seal, felt, steering knuckle, lower oil.
C53233.....	Hub.	A146173.....	Seal, felt, steering knuckle, upper oil.
C53594B.....	Knuckle, steering, L. H.	A146171.....	Seal, oil.
C53594A.....	Knuckle, steering, R. H.	A146175.....	Spacer, thrust bearing.
A146157.....	Lock, jam nut.	A146167.....	Spring, steering knuckle pin.
A146159.....	Nut, adjusting.	A152249.....	Stud, $\frac{1}{4}$ -14NF-2 by $3\frac{5}{8}$.
A146135B.....	Nut, disk and rim wheel stud, L. H.	A146176.....	Stud, disk and rim wheel, L. H.
A146135A.....	Nut, disk and rim wheel stud, R. H.	A146168.....	Stud, disk and rim wheel, R. H.
A146158.....	Nut, jam, outer bearing.	BE CX1K.....	Washer, lock, reg., $\frac{3}{8}$ by $\frac{1}{8}$ by $\frac{3}{32}$.
BBBX2C.....	Nut, reg., hex., s-fin., $\frac{3}{4}$ -16NF-2.	BE CX1S.....	Washer, lock, reg., $\frac{7}{8}$ by $1\frac{1}{64}$ by $\frac{3}{16}$.
		D26359.....	Wheel, automobile, disk and rim, 22 by 8, group assembly w/9.75-22 type B tire.



Reference	Item	Reference	Item
D26865.....	Axle, rear (for mounts Nos. 121 to 163, incl.).	A146158.....	Nut, jam, outer bearing.
D26937.....	Axle, rear (for mounts Nos. 164 and up).	BBBX2C.....	Nut, reg., hex., s-fin., $\frac{3}{4}$ -16NF-2.
B127236.....	Cap, disk and rim wheel hub.	BBBX2D.....	Nut, reg., hex., s-fin., $\frac{3}{8}$ -14NF-2.
TRB 6379.....	Cone and roller, taper roller bearing, large, assembly.	A146183.....	Pin, S., .254 by $\frac{1}{16}$.
TRB 557-S.....	Cone and roller, taper roller bearing, small.	Q52A.....	Plug, pipe, M. I., sq-hd., $\frac{1}{8}$ in.
TRB 6320.....	Cup, taper roller bearing, large.	A146162.....	Ring, lock.
TRB 552A.....	Cup, taper roller bearing, small.	BCDX1BB.....	Screw, cap, fl-hd., $\frac{1}{2}$ -13NC-2 by $\frac{1}{4}$.
B127235.....	Gasket, disk and rim wheel hub cap.	BCAX1CB.....	Screw, cap, hex-hd., $\frac{3}{8}$ -16NC-2 by $\frac{7}{8}$.
C53233.....	Hub.	A146171.....	Seal, oil.
A146157.....	Lock, jam nut.	A152249.....	Stud, $\frac{1}{4}$ -14NF-2 by $3\frac{1}{2}$.
A146159.....	Nut, adjusting.	A146176.....	Stud, disk and rim wheel, L. H.
A146135B.....	Nut, disk and rim wheel stud, L. H.	A146168.....	Stud, disk and rim wheel, R. H.
A146135A.....	Nut, disk and rim wheel stud, R. H.	BE CX1K.....	Washer, lock, reg., $\frac{3}{8}$ by $\frac{1}{2}$ by $\frac{3}{32}$.
		BE CX1S.....	Washer, lock, reg., $\frac{7}{8}$ by $1\frac{1}{64}$ by $\frac{3}{16}$.
		D26359.....	Wheel, automobile, disk and rim, 22 by 8, group assembly, w/9.75-22 type B tire.

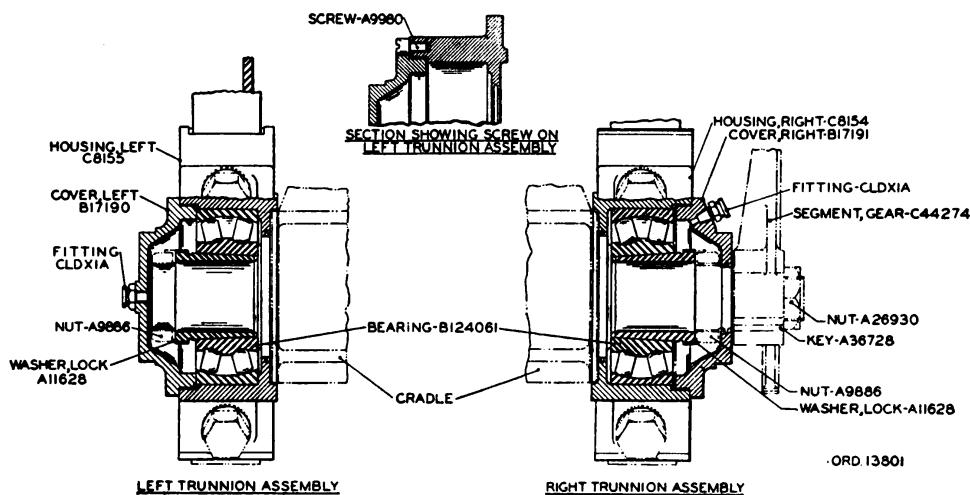


FIGURE 15.—Left and right trunnion bearings.

Reference	Item	Reference	Item
B124061.....	Bearing, roller, trunnion (w/split tapered sleeve).	C8154.....	Housing, trunnion roller bearing, right (welded construction).
B17190.....	Cover, trunnion roller bearing, left.	A36728.....	Key, 0.377 sq. by $1\frac{1}{8}$.
B17191.....	Cover, trunnion roller bearing, right.	A26930.....	Nut, gear segment retaining.
CLDX1A.....	Fitting, lubr., b-hd. type, stght., $\frac{1}{4}$ -27NPT, male.	A9886.....	Nut, trunnion.
C8155.....	Housing, trunnion roller bearing, left (welded construction).	A9880.....	Screw, trunnion roller bearing cover locking, left.
		C44274.....	Segment, gear.
		A11628.....	Washer, lock, trunnion nut.

APPENDIX

LIST OF REFERENCES

1. Standard nomenclature lists:

Tools, special repair, for heavy field and anti- SNL D-14.
 aircraft artillery.
 Matériel, 3-inch antiaircraft gun, M1A1 and SNL D-17.
 M2A1 (mobile).
 Matériel, 3-inch antiaircraft gun, M2A2 (mo- SNL D-23.
 bile).

2. Technical manuals:

3-inch antiaircraft gun matériel, mobile----- TM 9-360.
 Cleaning and preserving materials----- TM 9-850 (now pub-
 lished as TR 1395-
 A).
 Star gaging equipment and gutta percha im- TM 9-1860 (now pub-
 pressions. lished as supple-
 ment to SNL N-9).
 Pressure gage outfits for cannon----- TM 9-1870.
 Fire control and sighting equipment units---- TM 9-1610 to TM
 9-1669.
 Ordnance maintenance procedure—matériel TM 9-1100.
 inspection and repair.

3. Ordnance field service bulletins:

Maintenance of matériel in hands of troops--- OFSB 4-1.
 Electric and oxyacetylene welding----- OFSB 5-2.

4. Ordnance proof manual (proof of guns and carriages)

5. Drawings:

3-inch anti-aircraft gun, M1.....	Class 52, Division 207.
3-inch anti-aircraft gun, M3.....	Class 52, Division 212.
3-inch anti-aircraft gun mount, M2A2.....	Class 2, Division 287.
3-inch anti-aircraft gun mount, M2A1.....	Class 2, Division 245.
3-inch anti-aircraft gun mount, M1A1.....	Class 2, Division 231.
3-inch anti-aircraft gun mount, T1A2.....	Class 2, Division 217.
3-inch anti-aircraft gun mount, T1A1.....	Class 2, Division 217.

[A. G. 062.11 (5-28-40).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

E. S. ADAMS,
Major General,
The Adjutant General.

5. Drawings:

Class 3, Division 207	3-inch anti-aircraft gun, M1
Class 3, Division 212	3-inch anti-aircraft gun, M1
Class 3, Division 287	3-inch anti-aircraft gun, M1
Class 3, Division 245	3-inch anti-aircraft gun, M1
Class 3, Division 281	3-inch anti-aircraft gun, M1
Class 3, Division 217	3-inch anti-aircraft gun, M1
Class 3, Division 217	3-inch anti-aircraft gun, M1

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